High Precision Battery Monitor

# SBM-02

GB Owner's manual

Thank you for purchasing a Studer Battery Monitor. Please read this owner's manual for information about using the product correctly and safely. Keep this owner's manual close to the battery monitor for future reference.

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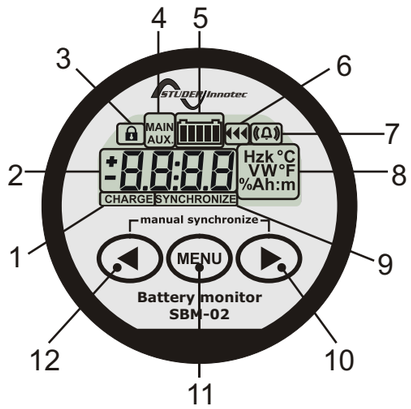
*Before proceeding with this owner's manual, please make sure you have carefully read the enclosed installation and quick start guide as well!*

## 1. SBM-02 display and control overview




1. Charge battery indicator
2. Numeric value indicator field
3. Setup lock / Master lock indicator
4. Main battery or Auxiliary battery indicator
5. State-of-charge bar
6. Charging in progress indicator
7. Alarm activated indicator
8. Readout units
9. Synchronize indicator
10. Next value or Right key (>)
11. Menu key
12. Previous value or Left key (<)

## 2. Synchronisation

In order to keep your battery monitor delivering accurate status information about your battery, it is important to regularly synchronize your battery monitor with your battery. As explained in the quick start guide, a synchronisation step is also needed before you can actually use your battery monitor. During operation, the battery monitor automatically indicates when a synchronisation is required, by displaying the message SYNCHRONIZE.

A synchronisation step means nothing more than performing a complete charge cycle on your battery. A charge cycle will be considered complete when all Auto-sync parameters F1.0, F1.1 and F1.2 (see chapter 5) are met. This typically means : when the battery charger switches to float mode. By meeting these conditions, the battery is considered full, which will be indicated by a flashing FULL message on the display. Besides this, the State-of-charge readout will be set to 100% and the Amphour readout reset to 0Ah. The FULL message will disappear when a key is pressed, or automatically, when the battery starts discharging again.

Performing synchronisations regularly is also important to keep your battery healthy and to increase it's lifetime. You will notice that if you are often performing full charge cycles yourselves, the battery monitor will most likely not display the SYNCHRONIZE message, since the battery is already kept in good sync with the battery monitor.

Besides automatic synchronisations based on meeting the Auto-Sync Functions, you can also manually synchronize the battery monitor with your battery when you are sure your battery is fully charged. This can be accomplished by pressing both < and > keys simultaneously for three seconds. After these three seconds, the flashing FULL message appears on the the display just like when it is automatically synchronized.

## 3. Status menu

The Status menu is a read only menu that shows the battery monitor's current status of several items. This menu can be accessed by the following sequence:

[3 sec] MENU → StAt — [1x] MENU → St.1

When the Status menu is entered, you can use the < and > keys to browse through the different status items. By pressing the MENU key, the selected status item can be viewed. Pressing the MENU key again, will then step back to the Status menu. From any menu position, the Normal Operating Mode can be accessed again by pressing the MENU key for 3 seconds. The following Status menu items are available :

St.1 Alarm Status. When multiple alarms are activated, use the < or > keys to browse through the currently active alarms. When no alarms are activated, this item displays "----".

St.2 Days running. The number of days the battery monitor is operating to monitor your battery. This item resets when a battery reset is executed (see Reset menu).

St.3 Days since last synchronized. The number of days the battery monitor has not been synchronized. This item resets when the battery monitor is synchronized or when a battery reset is executed (see Reset menu).

St.4 Charge Efficiency Factor (CEF). The charge efficiency factor used by the battery monitor. Depending on the value set in Function F5.6, this item displays the automatically calculated CEF or the manually set CEF.

## 4. History menu

The History menu is a read only menu that shows the battery monitor's History data. History data are special events that are stored in internal memory. This menu can be accessed by the following sequence :

[3 sec] MENU → StAt — [1x] ▶ → h,St — [1x] MENU → H 1.0

When the History menu is entered, you can use the < and > keys to browse through the different History items. By pressing the MENU key, the selected History item can be viewed. Pressing the MENU key again, will then step back to the History menu. From any menu position, the Normal Operating Mode can be accessed again by pressing the MENU key for 3 seconds. The following History menu items are available :

**H1 : BATTERY HISTORY :**

H1.0 Average discharge in Ah. This number will be recalculated after each synchronization.

H1.1 Average discharge in %. This number will be recalculated after each synchronization.

H1.2 Deepest discharge in Ah.

H1.3 Deepest discharge in %.

H1.4 Total Amphours removed. The total number of Amphours removed from the battery. When exceeding 10000Ah, the units are kAh and the value displayed must be multiplied by 1000.

H1.5 Total Amphours charged. The total number of Amphours charged to the battery. These Amphours are not compensated by the Charge Efficiency Factor (CEF). When exceeding 10000Ah, the units are kAh and the value displayed must be multiplied by 1000.

H1.6 Number of cycles.

H1.7 Number of synchronizations. This is the number of times the battery is fully charged meeting the Auto-sync Functions.

H1.8 Number of full discharges. The number of times the battery has been fully discharged reaching a State-of-charge of 0.0%.

**H2 : ALARM HISTORY**

H2.0 Number of Low Battery alarms.

H2.1 Number of Main battery low voltage alarms.

H2.2 Number of Auxiliary battery low voltage alarms.

H2.3 Number of Main battery high voltage alarms.

H2.4 Number of Auxiliary battery high voltage alarms.

## 5. Function setup menu

In the Function setup menu, your battery monitor can be adjusted to fit into your system. Lots of parameters, called Functions, can be set according to your needs. This menu can be accessed by the following sequence :

[3 sec] MENU → StAt — [2x] ▶ → Func — [1x] MENU → F 1.0

When the Function setup menu is entered, you can use the < and > keys to browse through the different Functions. By pressing the MENU key, the selected Function value can be viewed. The < and > keys can now be used to change this value. Pressing the MENU key again, will then step back to the Function menu. From any menu position, the Normal Operating Mode can be accessed again by pressing the MENU key for 3 seconds. This will also save any Function value changes to internal memory. When no keys are pressed for 90 seconds while operating in the Function setup menu, the battery monitor will automatically return to the Normal Operating Mode again without saving any Function value changes.The following Functions are available :

**F1 : SYSTEM PROPERTIES**

F1.0 Charger's float voltage (Auto-sync parameter). This value must be equal to your battery charger's float voltage. which is the last stage of the charging process. In this stage the battery is considered full.
Default : 13.2V Range : 8.0V - 33.0V Step size : 0.1V

F1.1 Charger's float current (Auto-sync parameter). When the charge current is below this percentage of the battery capacity (see Function F5.0), the battery will be considered as fully charged. Make sure this Function value is always greater than the minimum current at which the charger maintains the battery or stops charging.
Default : 2.0% Range : 0.5 - 10.0% Step size : 0.1%

F1.2 Auto-sync time (Auto-sync parameter). This is the time the Auto-sync parameters F1.0 and F1.1 must be met in order to consider the battery as fully charged.
Default : 240sec Range : 5 - 300sec Step size : variable

F1.3 Discharge floor. This is the reference point at which the battery needs to be recharged. When the State-of-charge percentage falls below this value the Charge battery indicator starts flashing while the time remaining readout shows *0:00* and the State-of-charge bar is empty.
Default : 50% Range : 0 - 99% Step size : 1%

F1.4 Battery temperature. In this Function the average battery temperature can be adjusted. The value *AU* enables the automatic temperature measurement, provided that an external temperature sensor is connected to the battery monitor. Also the temperature readout in the Normal Operating Mode is enabled.
Default : +20°C Range : -20..+50°C / AU Step size : 1°C

F1.5 Time remaining averaging filter. Specifies the time window of the moving averaging filter. There are three settings, where setting 0 gives the fastest Time remaining readout response and setting 2 the slowest. The best setting will depend on the type of battery load and your personal preference.
Default : 1 Range : 0 - 2 Step size : 1

**F2 : LOW BATTERY ALARM SETTINGS**

F2.0 Low battery alarm On (% SOC). When the State-of-charge percentage has fallen below this value, the alarm relay will be activated (depending on F2.6).
Default : 50% Range : 0 - 99% Step size : 1%

F2.1 Low battery alarm On (Volts). When the battery voltage has fallen below this value, the alarm relay will be activated (depending on F2.6).
Default : 10.5V Range : 8.0 - 33.0V Step size : 0.1V

F2.2 Low battery alarm Off (% SOC). When the State-of-charge percentage has risen above this value and the alarm relay was activated, the alarm relay will deactivate again. When "FULL" is selected, the alarm relay is deactivated when the Auto-sync parameters are met.
Default : 80% Range : 1 - 100% / FULL Step size : 1%

F2.3 Low battery alarm On delay time. This is the time the Low battery alarm On conditions, F2.0 and F2.1, must be met before the alarm is activated.
Default : 10sec Range : 0 - 300sec Step size : variable

F2.4 Minimum 'Alarm On' time. Minimum time that the alarm relay stays activated even if the State-of-charge percentage has risen above the Low battery alarm Off setpoint (F2.2). Function units are hours:minutes.
Default : 0:00 Range : 0:00 - 12:00 Step size : variable

F2.5 Maximum 'Alarm On' time. Maximum time that the alarm stays activated even if the the State-of-charge percentage is still below the Low battery alarm Off setpoint (F2.2). The value "-:--" indicates an unlimited time, and the relay will stay activated until the State-of-charge percentage has risen above the Low battery alarm Off setpoint (F2.2). Function units are hours:minutes
Default : -:- - Range : 0:00 - 12:00 / -:- - Step size : variable

F2.6 Enable Low battery alarm / Use contact. Select "OFF" to disable the low battery alarm. Select "[1]" to use the battery monitor's internal alarm relay. Select "[ ]1" to "[ ]8" to use an external alarm contact (only for use with optional Alarm output expander).
Default : [1] Range : OFF / [1] / [ ]1..[ ]8

**F3 : LOW VOLTAGE ALARM SETTINGS**

F3.0 Main battery low voltage alarm On. When the Main battery voltage falls below this value, the message "Lo" will appear on the display and the selected alarm relay will be activated (depending on F3.2).
Default : 10.5V Range : 8.0 - 33.0V Step size : 0.1V

F3.1 Main battery low voltage alarm Delay. This is the time the Main battery low voltage alarm On condition, F3.0, must be met before the alarm is activated.
Default : 10sec Range : 0 - 300sec Step size : variable

F3.2 Enable Main battery low voltage alarm / Use contact. Select "OFF" to disable the Main battery low voltage alarm. Select "[1]" to use the battery monitor's internal alarm relay. Select "[ ]1" to "[ ]8" to use an external alarm contact (only for use with optional Alarm output expander).
Default : OFF Range : OFF / [1] / [ ]1..[ ]8

F3.3 Auxiliary battery low voltage alarm On. When the Auxiliary battery voltage falls below this value, the message "Lo" will appear on the display and the selected alarm relay will be activated (depending on F3.5).
Default : 10.5V Range : 8.0 - 33.0V Step size : 0.1V

F3.4 Auxiliary battery low voltage alarm Delay. This is the time the Auxiliary battery low voltage alarm On condition, F3.3, must be met before the alarm is activated.
Default : 10sec Range : 0 - 300sec Step size : variable

F3.5 Enable Auxiliary battery low voltage alarm / Use contact. Select "OFF" to disable the Auxiliary battery low voltage alarm. Select "[1]" to use the battery monitor's internal alarm relay. Select "[ ]1" to "[ ]8" to use an external alarm contact (only for use with optional Alarm output expander).
Default : OFF Range : OFF / [1] / [ ]1..[ ]8

**F4 : HIGH VOLTAGE ALARM SETTINGS**

F4.0 Main battery high voltage alarm On. When the Main battery voltage rises above this value, the message "Hi" will appear on the display and the selected alarm relay will be activated (depending on F4.2).
Default : 16.0V Range : 10.0 - 35.0V Step size : 0.1V

F4.1 Main battery high voltage alarm Delay. This is the time the Main battery high voltage alarm On condition, F4.0, must be met before the alarm is activated.
Default : 5sec Range : 0 - 300sec Step size : variable

F4.2 Enable Main battery high voltage alarm / Use contact. Select "OFF" to disable the Main battery high voltage alarm. Select "[1]" to use the battery monitor's internal alarm relay. Select "[ ]1" to "[ ]8" to use an external alarm contact (only for use with optional Alarm output expander).
Default : OFF Range : OFF / [1] / [ ]1..[ ]8

F4.3 Auxiliary battery high voltage alarm On. When the Auxiliary battery voltage rises above this value, the message “Hi” will appear on the display and the selected alarm relay will be activated (depending on F4.5).

Default : 16.0V Range : 10.0 - 35.0V Step size : 0.1V

F4.4 Auxiliary battery high voltage alarm Delay. This is the time the Auxiliary battery high voltage alarm On condition, F4.3, must be met before the alarm is activated.

Default : 5sec Range : 0 - 300sec Step size : variable

F4.5 Enable Auxiliary battery high voltage alarm / Use contact. Select “OFF” to disable the Auxiliary battery high voltage alarm. Select “[1]” to use the battery monitor's internal alarm relay. Select “[ ]1” to “[ ]8” to use an external alarm contact (only for use with optional Alarm output expander).

Default : OFF Range : OFF / [1] / [ ]1..[ ]8

**F5 : ‘MAIN’ BATTERY PROPERTIES**

F5.0 Battery capacity. Your Main battery’s capacity in Amphours (Ah).

Default : 200Ah Range : 20 - 9990Ah Step size : variable

F5.1 Nominal discharge rate (C-rating). The discharge rate (in hours) at which the battery manufacturer rates your battery’s capacity.

Default : 20h Range : 1 - 20h Step size : 1h

F5.2 Nominal temperature. The temperature at which the battery manufacturer rates your battery’s capacity.

Default : 20°C Range : 0 - 40°C Step size : 1°C

F5.3 Temperature coefficient. This is the percentage that your battery’s capacity changes with temperature. The unit of this value is percent capacity per degree Celsius. The setting “OFF” disables temperature compensation.

Default : 0.50%cap/°C Range : OFF / 0.01 - 1.00 Step size : 0.01%cap/°C

F5.4 Peukert's exponent. The Peukert’s exponent represents the effect of reducing battery capacity at higher discharge rates. When the Peukert value of your battery is unknown, it is recommended to keep this value at 1.25. A value of 1.00 disables the Peukert compensation.

Default : 1.25 Range : 1.00 - 1.50 Step size : 0.01

F5.5 Self-discharge rate. This is the rate at which the battery loses capacity by itself, even when it is not used. The unit of this value is percent capacity per month at the Nominal temperature (F5.2). The setting “OFF” disables self-discharge compensation.

Default : 3.0%/month Range : OFF / 0.1 - 25.0%/month Step size : 0.1%/month

F5.6 Charge Efficiency Factor (CEF). CEF is the ratio between the energy removed from a battery during discharge and the energy used during charging to restore the original capacity. It is recommended to keep keep this value at “AU” (automatic calculation). The setting “100” disables charge efficiency compensation.

Default : AU Range : 50 - 100% / AU Step size : 1%

**F6 : BATTERY MONITOR PROPERTIES**

F6.0 Firmware version. Displays the firmware version of the battery monitor (read only).

Default : x.xx

F6.1 Shunt Amp Rating. This Function is linked to F6.2 and represents the Amp rating of your shunt at the given voltage indicated by F6.2. Included with your battery monitor is a 500Amp/50mV shunt, meaning that at 500A flowing through the shunt, a voltage of 50mV is generated across the small ‘Kelvin’ screw terminals of the shunt. This voltage will be used by the battery monitor to measure the amount of current.

Default : 500A Range : 10 - 9000A Step size : variable

F6.2 Shunt milliVolt Rating. This Function represents the milliVolt rating of your shunt at the given current indicated by F6.1. The battery monitor supports 50mV and 60mV shunts.

Default : 50mV Range : 50 / 60mV

F6.3 Backlight mode. Represents the duration of backlight activation in seconds after key-press. The backlight can also be set to be always “ON” or always “OFF”. Function setting “AU”, activates the backlight automatically when charge / discharge current exceeds 1Amp or when a key is pressed.

Default : 30sec Range : OFF / 5…300 / ON / AU Step size : variable

F6.4 Alarm contact polarity. Enables selection between a normally open (NO) or normally closed (NC) contact.

Default : NO Range : NO / NC

F6.5 Voltage prescaler. This Function is only important when an optional voltage prescaler is installed on the battery monitor. All voltage related Functions are linked to this Function F6.5. Always keep this Function set to “1-1” when no prescaler is installed!

Default : 1-1 Range : 1-1 / 1-5 / 1-10

F6.6 Temperature unit selection. Enables selection between degrees Celsius (°C) and degrees Fahrenheit (°F) in the temperature readout.

Default : °C Range : °C / °F

F6.7 Auxiliary input mode. This Function is used to configure the VA input terminal on the rearside of the battery monitor, and can be set in two modes. In mode “0”, the VA input operates in normal voltage measurement mode. In mode “1”, the VA input can be used to control the backlight. In this mode, the backlight is switched ON at an input voltage higher than 2V and switched OFF again if the voltage is below 1V.

Default : 0 Range : 0 / 1

F6.8 Communication mode. This Function is used to configure the data output mode. There are four data output modes :
Mode “0” : SBM-02 (broadcasting)
Mode “1” : SBM-02 (request mode)
Mode “2” : SBM-01 compatibility mode (broadcasting)
Mode “3” : SBM-01 compatibility mode (request only)

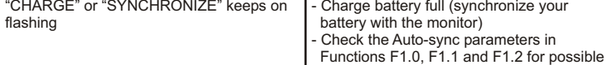
Default : 0 Range : 0 / 1 / 2 / 3

F6.9 Setup lock. When set to “ON”, all functions (except this one) are locked and cannot be altered. The Reset menu is also locked.

Default : OFF Range : OFF / ON

## 6. Reset menu

In the Reset menu, you can reset a number of items of your battery monitor This menu can be accessed by the following sequence :




When the Reset menu is entered, you can use the < and > keys to browse through the different reset items. By pressing the MENU key, the selected reset item can be viewed. The default value for all reset items is “OFF”. To actually reset the selected item, use the < and > keys to change the value from “OFF” to “ON”. Pressing the MENU key again, will step back to the Reset menu. All reset items set to “ON” will only be reset once the Normal Operating Mode is accessed again by pressing the MENU key for 3 seconds. The following Reset menu items are available :

rSt.a Reset alarms. Use this reset item to reset or ignore all current alarms.

rSt.b Reset Battery status. Use this reset item to reset your current battery status (CEF, State-of-charge and battery history). You can use this reset item after you have installed a fresh battery of the same specifications as the previous one.

rSt.F Reset Functions. This reset item can be used to reset all Function values to factory default values.

## 7. Troubleshooting guideline

| Problem | Remedy or suggestion |
|---|---|
| The monitor doesn't operate (no display) | - Check monitor- and battery side connections.<br>- Make sure the inline fuses are installed and not blown.<br>- Check battery voltage. Battery might be flat. Vbatt must be >8VDC.<br>- Try to restart the monitor by removing / placing the fuses again. |
| Current readout gives wrong polarity (positive current instead of negative when discharging) | - Current sense leads from the shunt are reversed. Check the installation guide. |
| The monitor resets all the time | - Check the wiring for corrosion and / or loose contacts.<br>- Battery might be flat or defective. |
| No changes can be made in the Function setup | - Check if the setup-lock is OFF (Function F6.9)<br>- Your SBM-02 might be locked by the superlock. Ask the installer for the password to unlock the monitor using the PC-link. |
| “CHARGE” or “SYNCHRONIZE” keeps on flashing | - Charge battery full (synchronize your battery with the monitor)<br>- Check the Auto-sync parameters in Functions F1.0, F1.1 and F1.2 for possible wrong settings. |
| State-of-charge and/or time-to-go readout not accurate | - Check if all current is flowing through the shunt (the negative terminal of the battery may only contain the wire going to the battery-side of the shunt!).<br>- Current sense leads from the shunt are reversed.<br>- Check all Battery properties Functions (F5)<br>- Check if battery monitor is synchronized. |
| Display returns '- - - -' in temperature readout | - Connection with temperature sensor is lost. Check for failed connections and/or cable damage. |
| Battery voltage readout is highly inaccurate | - Check prescaler setting in Function F6.5 |

## 8. Warranty conditions

Studer warrants this product to be free from defects in workmanship or materials for 24 months from the date of purchase. During this period Studer will repair the defective product free of charge. Studer is not responsible for any costs of the transport of this product.

This warranty is void if the product has suffered any physical damage or alteration, either internally or externally, and does not cover damage arising from improper use[1)] or from use in an unsuitable environment.

This warranty will not apply where the product has been misused, neglected, improperly installed or repaired by anyone other than Studer. Studer is not responsible for any loss, damage or costs arising from improper use, use in an unsuitable environment or improper installing, setup and malfunctioning of the product.

Since Studer cannot control the use and installation (according to local regulations) of their products, the customer is always responsible for the actual use of these products. Studer products are not designed for use as cricital components in life support devices or systems, that can potentially harm humans and/or the environment. The customer is always responsible when implementing Studer products in these kind of applications. Studer does not accept any responsibility for any violation of patents or other rights of third parties, resulting from the use of the Studer product. Studer keeps the right to change product specifications without previous notice.

[1)] Examples of improper use are :
- too high input voltage applied
- wrong shunt connection
- applying battery voltage to shunt input
- mechanically stressed enclosure or internals due to harsh handling and/or incorrect packaging
- contact with any liquids or oxidation caused by condensation

## 9. Technical specifications

| Parameter | | SBM-02 |
|---|---|---|
| Supply voltage range | | 9..35VDC |
| Supply current [1)] : | @Vin=24VDC | 7mA |
| | @Vin=12VDC | 9mA |
| Input voltage range (auxiliary battery) | | 2..35VDC |
| Input voltage range (main battery) | | 0..35VDC |
| Input current range[2)] | | -9999..+9999A |
| Battery capacity range | | 20..9990Ah |
| Operating temperature range | | -20..+50°C |
| Readout resolution : | voltage (0..35V) | ± 0.01V |
| | current (0..200A) | ± 0.1A |
| | current (200..9999A) | ± 1A |
| | amphours (0..200Ah) | ± 0.1Ah |
| | amphours (200..9990Ah) | ± 1Ah |
| | state-of-charge (0..100%) | ± 0.1% |
| | time-to-go (0..24hrs) | ± 1minute |
| | time-to-go (24..240hrs) | ± 1hr |
| | temperature (-20..50°C)[3)] | ± 0.5°C |
| Voltage measurement accuracy | | ± 0.3% |
| Current measurement accuracy | | ± 0.4% |
| Dimensions : | frontpanel | ø 64mm |
| | body diameter | ø 52mm |
| | total depth | 79mm |
| | Weight | 95grams |
| Shunt dimensions : | footprint | 45 x 87mm |
| | height | 17mm (base) / 35mm (M8 screws) |
| | weight | 145 grams |
| Protection class | | IP20 (frontpanel only IP 65) |
| Accessories | | - SBM-CAB-20, Conn.kit 20m<br>- SBM-TEMP-20, Temp.kit 20m<br>- SBM-COM, Communication kit RS232<br>- SBM-PS-01, Voltage prescaler 1:5 |

*Note: the given specifications are subject to change without notice.*

[1)] Measured with backlight and alarm relay turned off.
[2)] Depends on selected shunt. With standard delivered 500A/50mV shunt (350A continuous), the range is limited to -600..+600A.
[3)] Only available when optional temperature sensor is connected.

## 10. Declaration of conformity

CE

MANUFACTURER : Studer Innotec

ADDRESS : R. des Casernes 57
CH-1950 Sion
Switzerland

Declares that the following products :

PRODUCT TYPE : BATTERY MONITOR
MODEL : SBM-02

Conforms to the requirements of the following Directives of the European Union :
EMC Directive 2004/108/EC
RoHS Directive 2002/95/EC

The above product is in conformity with the following harmonized standards :
EN61000-6-3: 2001 EMC - Generic Emissions Standard
EN61000-6-2: 2005 EMC - Generic Immunity Standard